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[Title of the Invention] METHOD OF MANUFACTURING LIQUID CRYSTAL DISPLAY PANEL

[Abstract]

[Object] To prevent stripe alignment failures in a liquid crystal display panel having a columnar spacer.

[Solving Means] A color filter substrate 1 having a columnar spacer 3 is subjected to rubbing by using a rubbing roll 17. If the color filter substrate 1 is sent only in the rotation direction while the rubbing roll 17 is rotated, alignment failures are caused from the base of the columnar spacer 3, and therefore, the color filter 1 is first sent to the direction 21 and then sent to the direction 22. Thus, a portion with insufficient rubbing is eliminated and uniform display is obtained.

[Claims]

[Claim 1] A method of manufacturing a liquid crystal display panel comprising a first substrate composed of a pixel for outputting the pixel light with respect to one surface of a transparent substrate and a black matrix for shielding between adjacent pixels, a second substrate disposed apart from the first substrate, each alignment film coated at the inside of the first substrate and the second substrate, liquid crystals injected through the alignment

film between the first substrate and the second substrate, and columnar spacers formed in a convex shape at the inside of the first substrate to uniformly maintain the thickness of the liquid crystal layer, the method comprising the steps of:

a first process of maintaining a rotational axis in a predetermined rubbing angle about the X axis and rubbing the alignment film of the first substrate by sending the first substrate in the +Y axis direction and -Y axis direction while rotating a rubbing roller when a standard transfer direction of the first and second substrates is indicated in the Y axis in a rubbing process of the alignment film and an axis which is perpendicular to the Y axis is indicated in the X axis;

a second process of maintaining a rotational axis of a rubbing roller in a predetermined rubbing angle about the X axis and rubbing the alignment film of the second substrate by sending the second substrate in the +Y axis direction and -Y axis direction while rotating the rubbing roller;

a third process of fixing the first substrate rubbed in the first process and the second substrate rubbed in the second process to maintain a predetermined gap using the columnar spacers and a sealant; and

a fourth process of injecting liquid crystals within a gap of the first and second substrates fixed in the third

process.

[Claim 2] A method of manufacturing a liquid crystal display panel comprising a first substrate composed of a pixel for outputting the pixel light with respect to one surface of a transparent substrate and a black matrix for shielding between adjacent pixels, a second substrate disposed apart from the first substrate, each alignment film coated at the inside of the first substrate and the second substrate, liquid crystals injected through the alignment film between the first substrate and the second substrate, and columnar spacers formed in a convex shape at the inside of the first substrate to uniformly maintain the thickness of the liquid crystal layer, the method comprising the steps of:

a first process of maintaining a rotational axis of a rubbing roller in a predetermined rubbing angle about the X axis and rubbing the alignment film of the first substrate by sending the first substrate in the +Y axis direction and -Y axis direction while rotating a rubbing roller when a standard direction depending on edges of the first and second substrates is indicated in the Y axis and an axis which is perpendicular to the Y axis is indicated in the X axis;

a second process of maintaining a rotational axis of a rubbing roller in a predetermined rubbing angle about the X

axis and rubbing the alignment film of the second substrate by sending the second substrate in the +Y axis direction and -Y axis direction while rotating the rubbing roller;

a third process of fixing the first substrate rubbed in the first process and the second substrate rubbed in the second process to maintain a predetermined gap using the columnar spacers and a sealant; and

a fourth process of injecting liquid crystals within a gap of the first and second substrates fixed in the third process.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a method of manufacturing a liquid crystal display panel which mainly employs a rubbing method.

[0002]

[Description of the Related Art]

A structure of a liquid crystal display panel and a method of manufacturing a conventional liquid crystal display panel will be described with reference to the accompanying drawings. Fig. 3 is a cross-sectional view illustrating a structure of a liquid crystal display panel. The liquid crystal display panel shown in the figure is

provided with a color filter substrate 1 as a first substrate. The color filter substrate 1 comprises a black matrix 2 and a flat film 9 formed on one surface of a transparent substrate and a ITO film 4 formed on the surface of the black matrix 2 and the flat film 9. The liquid crystal display panel comprises an alignment film 6, which is added in the color filter substrate 1, coated on the surface of the ITO film 4, is added to color filter substrate 1, a counter substrate 7 (a second substrate) opposite to the color filter substrate 1, columnar spacers 3 in which a gap between two substrates is sustained in a predetermined value, and liquid crystals 5 filled in a gap between two substrates.

[0003]

Fig. 4 is a top plan view illustrating a structure of a color filter substrate.

As shown in the figure, a pixel 8 made of R, G, and B is formed in a matrix shape and black matrixes 2x and 2y are formed between each pixel 8. The black matrix 2x is formed in the X direction and the black matrix 2y is formed in the Y direction and they optically shield adjacent pixels. The columnar spacer 3 is provided in a particular intersection among intersections of the black matrixes 2x and 2y. The columnar spacer 3 has a trapezoid-shaped section, as shown in Fig. 3 and has a function of uniformly maintaining a gap

between the color filter substrate 1 and a counter substrate 7. The columnar spacer 3 does a function that takes the place of a spherical spacer in a conventional liquid crystal display panel.

[0004]

A method of manufacturing a liquid crystal display panel thus composed will be described. First, a transparent substrate comprises a color filter composed of red color, blue color, and green color, the black matrix 2x extended in the X axis direction, and the black matrix 2y extended in the Y axis direction. A flat film 9 is formed on a portion in which the black matrix 2 is excluded, that is, a pixel 8. Thus, the color filter substrate 1 that is the first substrate is manufactured. Next, a transparent register made of a resin is coated on the color filter substrate 1 by a spin coating method or a printing method, etc. and its film thickness has a predetermined thickness within the range of 3 to 6μm. Next, by a photolithography process, as shown in Fig. 4, a resin is left in a specific intersection apart by a predetermined distance among intersections of the black matrix 2x and 2y and the columnar spacer 3 is formed.

[0005]

Next, the alignment film material are coated on the color filter substrate 1 in which the columnar spacer 3 is formed and a counter substrate 7 that is the second

substrate. As a costing method, a spin coating method or a printing method is used. The alignment film 6 is formed by curing an alignment film material. The thickness of the alignment film 6 thus formed is, for example, within the range of 2 to 6μm. Then, in order to align liquid crystals 5 in the fixed direction, the alignment films 6 of the color filter substrate 1 and the counter substrate 7 are subjected to rubbing.

[0006]

Fig. 8 is a cross-sectional view illustrating a method of manufacturing (rubbing) a liquid crystal display panel in a conventional technique and Fig. 9 is a top plan view thereof. As shown in Fig. 8, a rubbing roller 17 wound by cloth is rotated in the rotation direction 18. The color filter substrate 1 or the rubbing roller 17 itself is moved in the Y axis directions and thus it rubs the surface of the alignment film 6. As shown in Fig. 9, a direction which rubs the substrate is referred to a rubbing direction 15 and an angle formed between a direction perpendicular to an advancing direction of the substrate 19 and a central axis of the rubbing roller 17 is referred to a rubbing angle 16.

[0007]

Fig. 5 or Fig. 7 is a diagram illustrating a rubbing direction of an alignment film 6 in two substrates and a twist angle of liquid crystal. Generally, in the TFT panel,

a twist angle 14 of the liquid crystals 5 is 90 degree in a left side direction, as shown in Fig. 5(a). Further, in the STN panel, the twist angle 14 of the liquid crystals 5 is within the range of 220 to 270 degree in a right side direction, as shown in Fig. 6(a). Here, the twist angle 14 of the displayed liquid crystal, as shown in Figs. 5(a) to Fig. 7(a), is an angle formed between the rubbing direction 12 (arrow of dotted line) of a front substrate and the rubbing direction 13 (arrow of solid line) of a back substrate.

[0008]

In the TFT panel, as shown in Fig. 5(b), the color filter substrate 1 and a counter substrate 7 are subjected to rubbing by setting the rubbing angle to the range of 16 to 45 degree. Further, in the STN panel, as shown in Fig. 6(b), the substrates are subjected to rubbing by setting the rubbing angle to the range of 20 to 45 degree. Then, a seal resin is printed in at least one of the color filter substrate 1 and the counter substrate 7 or coated in a predetermined position of the substrate by a dispenser, the color filter substrate 1 and the counter substrate 7 are positioned, the two substrates are bonded to each other, and the seal resin is cured. Then, according to a vacuum injection method, the liquid crystals 5 are filled up, an injection port is sealed with a sealant, and thus a liquid

crystal display panel is manufactured.

[0009]

[Problems to be Solved by the Invention]

However, in a conventional manufacturing method, when a columnar spacer 3 shown in FIG. 8 is subjected to rubbing in a rubbing direction 15 shown in Fig. 9, insufficient rubbing portion 20 is generated on a shadow portion of the columnar spacer 3. If this state generates, because the rubbing direction of the rubbing portion 20 is set in the half tone state, as can be seen in a halftone portion shown in FIG. 10, stripe alignment failures 20a are caused from the columnar spacer 3

[0010]

The present invention is to solve the above-mentioned problem, and an object of the present invention is to provide a method of manufacturing a liquid crystal display panel in which stripe alignment failures are not caused from a columnar spacer at rubbing process of a color filter substrate having the columnar spacer.

[0011]

In order to solve the above-mentioned problem, according to claim 1, a method of manufacturing a liquid crystal display panel comprising a first substrate composed of a pixel for outputting the pixel light with respect to one surface of a transparent substrate and a black matrix

for shielding between adjacent pixels, a second substrate disposed apart from the first substrate, each alignment film coated at the inside of the first substrate and the second substrate, liquid crystals injected through the alignment film between the first substrate and the second substrate, and columnar spacers formed in a convex shape at the inside of the first substrate to uniformly maintain the thickness of the liquid crystal layer, the method comprising the steps of: a first process of maintaining a rotational axis in a predetermined rubbing angle about the X axis and rubbing the alignment film of the first substrate by sending the first substrate in the +Y axis direction and -Y axis direction while rotating a rubbing roller when a standard transfer direction of the first and second substrates is indicated in the Y axis in a rubbing process of the alignment film and an axis which is perpendicular to the Y axis is indicated in the X axis; a second process of maintaining a rotational axis of a rubbing roller in a predetermined rubbing angle about the X axis and rubbing the alignment film of the second substrate by sending the second substrate in the +Y axis direction and -Y axis direction while rotating the rubbing roller; a third process of fixing the first substrate rubbed in the first process and the second substrate rubbed in the second process to maintain a predetermined gap using the columnar spacers and a sealant;

and a fourth process of injecting liquid crystals within a gap of the first and second substrates fixed in the third process.

[0012]

According to claim 2, a method of manufacturing a liquid crystal display panel comprising a first substrate composed of a pixel for outputting the pixel light with respect to one surface of a transparent substrate and a black matrix for shielding between adjacent pixels, a second substrate disposed apart from the first substrate, each alignment film coated at the inside of the first substrate and the second substrate, liquid crystals injected through the alignment film between the first substrate and the second substrate, and columnar spacers formed in a convex shape at the inside of the first substrate to uniformly maintain the thickness of the liquid crystal layer, the method comprising the steps of: a first process of maintaining a rotational axis of a rubbing roller in a predetermined rubbing angle about the X axis and rubbing the alignment film of the first substrate by sending the first substrate in the +Y axis direction and -Y axis direction while rotating a rubbing roller when a standard direction depending on edges of the first and second substrates is indicated in the Y axis and an axis which is perpendicular to the Y axis is indicated in the X axis; a second process

of maintaining a rotational axis of a rubbing roller in a predetermined rubbing angle about the X axis and rubbing the alignment film of the second substrate by sending the second substrate in the +Y axis direction and -Y axis direction while rotating the rubbing roller; a third process of fixing the first substrate rubbed in the first process and the second substrate rubbed in the second process to maintain a predetermined gap using the columnar spacers and a sealant; and a fourth process of injecting liquid crystals within a gap of the first and second substrates fixed in the third process.

[0013]

According to the manufacturing method, by reciprocating the first substrate or the rubbing roller once or more, it is possible to prevent insufficient rubbing from generating in shadow portions of the columnar spacers.

[0014]

[Description of the Embodiments]

A method of manufacturing a liquid crystal display panel according to an embodiment of the present invention will be described with reference to the accompanying drawings. Fig. 1 is a cross-sectional view illustrating a method of rubbing a liquid crystal display panel according to an embodiment of the present invention and Fig. 2 is the top plan view thereof. In the figures, the same elements as

those of a conventional embodiment are denoted by like reference numerals and thus the descriptions will be omitted. Further, a structure of a liquid crystal display panel applied in a manufacturing method according to an embodiment of the present invention is the same as that shown in Fig. 3 and thus the descriptions will be omitted.

[0015]

In order to manufacture a liquid crystal display panel according to an embodiment of the present invention, first, similarly with a conventional technique, a transparent substrate comprises a color filter composed of red color, blue color, and green color, a black matrix 2x extended in the X direction, and a black matrix 2y extended in the Y direction, and thus a color filter substrate 1 that is a first substrate is manufactured. Next, a transparent register made of a resin is coated on the color filter substrate 1 in a predetermined thickness, for example, 3 to 6μm by a spin coating method or a printing method, etc. Next, the register is subjected to pre baking, a solvent is volatilized, and then the register are irradiated by ultraviolet rays through a photomask and exposed. The photo mask used in here has a pattern to leave a resin in the intersections of the black matrixes 2x and 2y.

[0016]

Next, the exposed register is subjected to developing,

cleaning, and post baking, and thus the columnar spacer 3 is formed. The first substrate thus formed and the counter substrate 7 that is the second substrate are coated with the alignment film material by a spin coating method or a printing method, etc. The coated alignment film material is subjected to curing and thus the alignment film having the film thickness, for example, of 2 to 6μm is formed. Then, in order to align the liquid crystals 5 in the fixed direction, the alignment film 6 of the color filter substrate 1 and the alignment film 6 of the counter substrate 7 are subjected to rubbing. Here, as shown in Fig. 2, in the rubbing process of the alignment film, when the standard transfer direction of the first and second substrates is referred to the Y axis and an axis which is perpendicular to the Y axis is referred to the X axis, and a rotational axis has a rubbing angle θ about the X axis. Further, the value of θ is determined by the kind of the liquid crystal.

[0017]

Here, a twist angle 14 of the liquid crystal 5 is 90 degree in the left direction for the TFT Panel, as shown in Fig. 5(a) and 250 degree in the right direction for the STN panel, as shown in Fig. 7. With respect to the color filter substrate 1 having the columnar spacer 3, as shown in Fig. 5(b), in the TFT panel, a rubbing roll 17 is set so that the

rubbing angle 16 is 45 degree about the Y axis. Further, as shown in Fig. 7(b), in the STN panel, a rubbing roll 17 is set so that the rubbing angle 16 is 35 degree about the Y axis.

[0018]

First, as shown in Figs. 1 and 2, the rubbing roller 17 sends the color filter substrate 1 in the direction 21 opposite to the direction that rubs the substrate and is subjected to rubbing in the first time. Next, the rubbing roller 17 sends the color filter substrate 1 in the same direction 22 as the direction that rubs the substrate and is subjected to rubbing in the second time.

[0019]

Therefore, a rubbing portion that is subjected to insufficient rubbing by the columnar spacer 3 in first rubbing is subjected to fully rubbing by the second rubbing. On the other hand, the rubbing roller 17 sends the counter substrate 7 in the same direction as the direction or the direction opposite to the direction that rubs the substrate and is subjected to rubbing. At this time, the rubbing condition is as follows: an advancing speed of the substrate is 40mm/s, a rotational spend of the rubbing roller 17 is 1200 rpm, and the pressure thickness is 350μm when fluffs of the rubbing roller 17 come in contact with the rubbing surface.

[0020]

Then, the seal resin is coated in a predetermined position on the color filter substrate 1 or the counter substrate 7 using a printing method or a dispenser. Next, in the TFT panel, the color filter substrate 1 and the counter substrate 7 are positioned so that the twist angle 14 of the liquid crystal 5 is 90 degree in the left direction by the second rubbing direction of the color filter substrate 1 and the rubbing direction of the counter substrate 7. Further, in the STN panel, the color filter substrate 1 and the counter substrate 7 are positioned so that the twist angle 14 is 250 degree in the right direction. In this state, two substrates are sealed to each other and the seal is cured. Then, the liquid crystal 5 is injected by the vacuum injection method, the injection port is sealed by sealant, and thus the liquid crystal display panel is completed.

[0021]

In the liquid crystal display panel thus manufactured, alignment failures 20a shown in Fig. 10 do not generate and it is possible to obtain a liquid crystal display panel in which stripe alignment failures are not caused from the columnar spacer 3.

[0022]

[Advantages]

As described above, according to the present invention, the color filter substrate 1 is sent in the reciprocating direction and the alignment film is subjected to rubbing and thus it is possible to align the base of the columnar spacer in a predetermined direction. Therefore, it is possible to obtain a liquid crystal display panel having no stripe alignment failures from the columnar spacer.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a cross-sectional view illustrating a method of manufacturing (rubbing) a liquid crystal display panel according to an embodiment of the present invention.

[Fig. 2]

Fig. 2 is a top plan view illustrating a method of manufacturing (rubbing) a liquid crystal display panel according to an embodiment of the present invention.

[Fig. 3]

Fig. 3 is a cross-sectional view illustrating a liquid crystal panel to be applied in a manufacturing method according to the present invention and a conventional technique.

[Fig. 4]

Fig. 4 is a top plan view illustrating a structure of a color filter substrate in a liquid crystal panel according to the present invention and a conventional technique.

[Fig. 5]

Fig. 5 is a diagram illustrating a rubbing direction of a TFT liquid crystal panel and a twist angle.

[Fig. 6]

Fig. 6 is a diagram illustrating a rubbing direction of a STN liquid crystal panel and a twist angle.

[Fig. 7]

Fig. 7 is a diagram illustrating a specific example of a rubbing direction of a STN liquid crystal panel and a twist angle.

[Fig. 8]

Fig. 8 is a cross-sectional view illustrating a method of manufacturing (rubbing) a liquid crystal display panel in a conventional technique.

[Fig. 9]

Fig. 9 is a top plan view illustrating a method of manufacturing (rubbing) a liquid crystal display panel in a conventional technique.

[Fig. 10]

Fig. 10 is a diagram illustrating stripe alignment defects extended from a columnar spacer when a liquid crystal display panel manufactured by a conventional rubbing method is lighted up in a half tone.

[Reference Numerals]

1: color filter substrate

2, 2x, 2y: black matrix

3: columnar spacer

4: ITO film

5: liquid crystal

6: alignment film

7: opposing substrate

8: pixel

9: flat film

12: rubbing direction of front substrate

13: rubbing direction of back substrate

14: twist angle

15: rubbing direction

16: rubbing angle

17: rubbing roller

18: rotation direction of rubbing roller

19: substrate advancing direction

20: insufficient rubbing portion

20a: alignment defects of stripe shape

22: substrate transfer direction of first rubbing

23: substrate transfer direction of second rubbing